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STEREOSCOPIC VIEWING SYSTEM

The present invention relates to a stereoscopic viewing system and, more particularly, to such a system adapted for viewing a stereoscopic image without the aid of spectacles or other image separating device located close to the eyes of a viewer.

BACKGROUND

Forms of stereoscopic television/video systems which provide stereoscopic viewing without the use of glasses or other encumbrances placed close to the eyes of a viewer are known. One such system is the so-called lenticular system wherein the image for viewing is made up of interleaved vertical image strips from two (left image and right image) camera views. In order to allow the eyes to resolve the two images into a single stereoscopic image, lens in the form of vertically arranged contiguous cylindric lens, or lens of other shapes, such as prisms, overlay the vertical image strips whereby, by refraction, the left image is directed towards the left eye of a viewer and the right image is directed towards the right eye of a viewer when the eyes are placed in a predetermined focal plane, or very near thereto. U.S. Patent No. 5,258,833 to Schenk describes this general background with reference to U.S. Patent No. 4,214,257 (Yamauchi) and U.S. Patent No. 2,543,793 (Marks). EP744872 discloses another implement action of stereoscopic image system wherein an electronically controlled shutter mechanism dynamically switches and direct the respective right and left images to the respective right and left eyes of an observer.

The light refracting element of a "lenticular" system often includes a lens such as lens element 48 shown, for example, in Figure 31A of EP744872. A good summary of the history and implementation of this kind of system is to be found in IEEE publication "Present Status of Three-Dimensional Television Research" in Proceedings of IEEE volume 83, No 7 July 1995. The systems described in those patents suffer from a sensitivity in the location of the focal plane for viewing and suffer from a large amount of light scatter which leads to distortion of the viewed image .

It is therefore desirable to ameliorate the above-mentioned problems and/or at least provide a useful alternative.

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It is also desirable to provide a improved stereoscopic viewing system which enables an image to viewed as a 3D image from a plurality of positions along or adjacent a focal plane.

It is also desirable to provide an improved stereoscopic image system which can be adapted for use with passive, reflective image sources, such as photographs, drawings or the like as well as active, light emitting image sources such as television screen, video displays or any other form of light emitting or light iminating optical systems.

It is also desirable to provide an improved stereoscopic viewing system which is relatively simple in its construction and implementation and is economical in use to provide the desired three dimensional image to a viewer.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a stereoscopic viewing system comprising a raw image of a subject, which raw image comprises an array of substantially vertical raw image strips wherein alternating strips are respectively strips taken from source images, being a right eye view image and a left eye view image of the subject, an array of substantially vertical lens strips interposed between the raw image and a focal plane spaced from the raw image, wherein the respective lens strips are positioned to receive light from the raw image strips and refract that received light to cause a stereoscopic image of the subject to be resolved on the focal plane, and masking means comprising a substantially planar array of vertical opaque strips interposed between the raw image and the said focal plane.

In one preferred embodiment of the invention, the source images are divided into adjacent vertical strips and those strips which are taken for the raw image strips comprise every other one of said respective image strips. Thus, the raw image is comprised of alternating left image strips and right image strips with each other one of the left and right source image strips being omitted.

In one embodiment of the invention, the masking means is disposed on the raw image. In another embodiment of the invention, the masking means is disposed on the lens strip of array. In a further embodiment of the invention, the masking means

comprises a separate mask member disposed between and spaced from the raw image and lens strip array.

In an embodiment of the invention, the vertical opaque strips forming the masking means are of substantially the same width as the said raw image strips and the vertical opaque strips have their centre lines respectively in register with alternate lines of junction between raw image strips. In this embodiment, the vertical lens strips are also of substantially the same width as the raw image strips and have their centre lines respectively in register with other alternate lines of junction between raw image strips.

In another embodiment of the invention, the raw image strips each contain three columns of pixels of different colours, for example Red, Green and Blue. In this embodiment, the opaque strips are of the same width as an individual pixel column while the lens strips are of a width equal to the width of the three columns. The opaque strips are spaced apart a distance equal to the width of the three columns.

The array of substantially vertical lens strips may be said to constitute a lenticular lens. Each individual lens may have a cylindric shape or, more preferably, be in the form of tri-elliptical lens. Alternatively, the lens may be of prismatic or other form to provide the desired refraction of received light.

In another form of the invention, each lens of the lenticular lens structure has a circular cross-section and is separated from adjacent lens by an opaque strip.

In a further form of the invention, the masking means is combined with the array of substantially vertical lens strips in such a way that the mask is formed as a base elongate portion of optical material into a first surface of which are formed spaced lens strips with the spaces between the strips being of the base optical material.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings wherein:-

Figure 1 illustrates the general layout of a stereoscopic viewing system to which embodiments of the present invention can be applied;

Figure 2 illustrates steps in the formation of raw stereoscopic image to which a first embodiment of the invention can be applied;

Figure 3 illustrates a mask applicable to the raw image of Figure 2 according to the first embodiment of the invention;

Figure 4 illustrates a mask applicable to a flat panel or plasma display;

Figure 5 illustrates a specific driver circuit for the production of an active raw image;

Figure 6 illustrates an arrangement of raw image and mask according to a further embodiment of the invention;

Figure 7 illustrates a raw image and mask layout according to a further embodiment of the invention;

Figure 8 is a detailed view in cross section of the lenticular lens of Figure 7; and

Figure 9 is a detailed view in side section of a lenticular lens incorporating a mask according to a further embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to Figure 1, there is shown a stereoscopic viewing system 10 comprising a raw image 11 and a lenticular lens 12 spaced form the raw image 11 a distance D. The lens 12 includes an optical arrangement whereby light rays from the raw image 11 are directed to either the left eye 13 or right eye 14 of a viewer 15 so as to form a three-dimensional image to the viewer. As herein after describes, the eyes of the viewer 15 will be located on a focal plane 25 or adjacent that focal plane such as indicated by the focal plane Width.

With reference to Figure 2, the raw image 11 is formed as follows:-

A stereoscopic raw image 11 is generated initially as two separate images comprising a left eye view 3 and a right eye view 4. The left eye view 3 is labelled image A whilst the right eye view 4 is labelled image B. Each image is then divided up into vertical strips 1 to 9 of equal pitch P. Alternate strips are then taken from the two images 3 and 4 as indicated by the arrows, emitting each second strip from each image 3 and 4. Thus, the strips A1, A3, A5,... are interleaved with the strips B2, B4, B6, B8... to produce the composite raw image 11. It will therefore be understood that the raw image 11, in this embodiment of the invention, comprises alternate strips taken from the left eye view image 3 and the right eye view image 4, and while parts of the left eye and right eye images are omitted from the final raw image 11, the viewer is unable to discern missing parts of the image.

The raw image "may be in the form of a photograph or like 'passive'/reflective image source or it may be in the form of a video display or like 'active'/light emitting image source. In either case, light reflected from or light emanating from the raw image" needs to be optically processed through a lenticular lens 12 so as to redirect the light rays for reconstruction by eyes 13, 14.

With reference to Figure 3 an implementation of a mask 17 according to the first embodiment of the invention is illustrated. Specifically Figure 3A shows the raw image 11 produced as described above and to which the mask 17 of Figure 3B is applied or overlaid.

The mask 17 comprises a plurality of opaque strips which overlie the alternate lines of junction between the raw image strips 16. The mask may either be applied directly to the raw image 11, as illustrated in the embodiments shown in Figures 6 and 7, or may be applied to or form part of the lenticular lens 12, as illustrated in Figures 8 and 9. Alternatively, the mask 17 may be a separate mask member interposed either between the raw image 11 and the lenticular lens 12 or between the lenticular lens 12 and the focal plane 25. Irrespective of its physical location, the mask effectively blocks light from the raw image 11 thereby facilitating the separation of left hand and right hand images to the respective left and right eyes of an observer.

If the mask 17 is incorporated into the lenticular lens 12, or constitutes a separate mask member, the displacement or distance D between the raw image 11 and the mask 17 can vary between 0 and typically around 2-14cms depending on the nature of the light refracting element used to form the lenticular lens 12.

With reference to Figure 4, the manner of construction of a colour raw image 18 is illustrated in Figure 4A and comprises alternating left image colour strips 19 and right image colour strips 20. Each image strip is, itself, comprised of three primary colour strips labelled R (red) G (green) and B (blue). The corresponding colour mask 21 is illustrated in Figure 4B and comprises opaque strip 24 which is of a width corresponding to the width of one of the primary colour strips labelled R, G and B. The opaque strips 24 are spaced apart a distance equalled to the width of the colour strips 19 and 20 so that the opaque strips 24 mask a red primary coloured strip R of one colour image strip 19, the green primary coloured strip green of the next colour strip 20, the blue primary colour strip B of the next colour strip 19, etc. Thus, the masking masks

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portion only of the alternating left and right image colour strips 19 and 20, but in such a way as to mask each of the three primary colour strips R, G and B in turn across the width of the raw image 18.

The opaque strips 24 may be incorporated with a lenticular lens 21 and extend between adjacent vertical lens strips 22 and 23 which are spaced apart by the width of the opaque strip 24. With this arrangement, the vertical lens strips 22 and 23 may be formed as tri-elliptical lens with each part specifically formed to refract one of the primary colour strips R, G or B.

The pitch of the opaque strip 24 is such as to cover a primary colour strip, a different colour strip in each consecutive occurrence. In this manner, it will be noted that the opaque strips remove some redundant image information according to a predetermined algorithm. The effect, it is postulated, is to widen the width W of the focal plane 25 of viewer 15 in which a stereoscopic image can be resolved.

Figure 5 illustrates a driver arrangement suitable for use with embodiments of the invention where an active display (such as CRT, LEDs or back lit matrix) is used wherein a parallax image source 26 resolves a stereoscopic image comprising a left eye image A and a right eye image B into an A data stream 27 and a B data stream 28 which are fed to screen driver 29 which resolves the data streams 27, 28 into respective vertical strip data streams 30, 31 which are directed to the respective vertical strips comprising raw image 11.

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Figure 6 illustrates in plan view a further embodiment of the invention comprising raw image 111 made up of respective left image strips 11~~4~~3 and right image strips 114, all of equal width or pitch P and having a mask formed of opaque strips 117 of width or pitch P laid thereover on the viewing side as illustrated in Figure 6. Specifically the opaque strips 117 are arranged so that each overlies half of the area of adjoining left and right image strips 113, 114.

In addition the stereoscopic viewing system 110 includes a lenticular lens system 112 comprised of a linear array of tri-elliptical 118 is itself formed from three intersecting strip lenses of ellipsoid cross-section as perhaps best seen in detail in Figure 8. The function of each of these lenses 118 is as typically found in "lenticular" stereoscopic systems, being to refract the light received from collective left image strips 113 to a left eye 115 of a viewer and to also refract (bend) the light received from

collective right image strips 114 to the right eye 116 of a viewer when located in a specified focal plane 119.

In this embodiment the lenses 118 are contiguously connected in a linear array as illustrated in Figure 6. The only masking of light information is performed by the opaque strips 117 located, in this instance, directly on the raw image 111 as illustrated.

Figure 7 illustrates a further embodiment of the invention comprising a stereoscopic viewing system 210 having a raw image 211 and a lenticular lens 212 wherein all other components are numbered as for the embodiment of Figure 6 where like components are utilised.

In this embodiment, the mask comprises both the opaque mask strips 117 which are applied directly to the raw image 212 as shown in Figure 6 as well as separate opaque mask elements 213 which are placed on the lenticular lens 212 between each tri-elliptical lens 118. With this form of masking, a reduction in the refracted light passing through the lenticular lens 212 increases the separation effect between the left hand raw image and the right hand raw image.

In this instance the width of the opaque mask elements 213 interconnecting the tri-elliptical lenses 118 is the dimension P.

With reference to Figure 8 a detailed cross section of the mask 212 of Figure 7 is illustrated showing the tri-elliptical lenses to be formed as part of an elongate strip of optical material 214 made form optical material having a refractive index between 1 and 2.

Particular materials which are suitable include clear plastic; glass, thermoset plastic (CR39); plexiglass; and acrylic resin in the form of methyl methacrylate (which has a specific refractive index of 1.49).

The strip 214 comprises a base elongate portion 215 into which one face has formed the tri-elliptical lens structure 118 and between which planar portions 216 having an opaque strip 217 applied thereover as illustrated in Figure 8.

Figure 9 illustrates an alternative lens 312 suitable for use with any of the previously mentioned embodiments of stereoscopic viewing system. The lens 312 comprises a linear array of spherical cross-section lenses 313 in between which are located opaque joining portions 314 formed as a square cross-section block having a

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triangular cross section opaque portion 315 located therein as generally illustrated in Figure 9.

The surface of the circular cross-section lenses 313 can be profiled as a set of planar portions forming a segmented planar approximation 316 to a cylindrical or curved surface.

The above describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope and spirit of the present invention.

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